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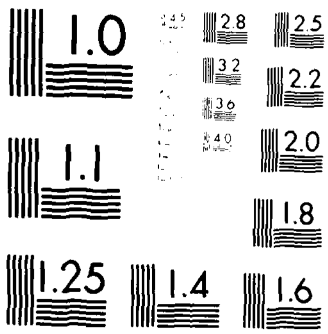

MICROCOPY RESOLUTION TEST CHART

ASD-TR-84-5032, Vol I

AUTOMATIC DYNAMIC AIRCRAFT MODELER (ADAM) VOLUME I

Hugh Griffis
Nuclear Survivability Group
System Survivability Branch
ASD/ENSSS
Wright-Patterson AFB OH 45433-6503

January 1985

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AERONAUTICAL SYSTEMS DIVISION
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This technical report has been reviewed and is approved for publication.

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The following manual is a description of the input required for Automatic Dynamic Aircraft Modeler (ADAM). ADAM is designed to generate NASTRAN structural models with minimal data or knowledge. The model generated by ADAM includes the executive, case control, and bulk data decks. The model is setup for eigenvalue analysis with the appropriate plotting commands.

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I Introduction

ADAM's documentation is in three volumnes: Users Manual, Demonstrated Problems Manual, and Programers Manual. Users Manual contains the input format and description of variables. Demonstrated Problems Manual contains example inputs to ADAM, example outputs of the summary table, and plots of the NASTRAN models generated by ADAM. The Programers Manual contains a listing of ADAM.

Input is in four groups and is illustrated in Appendix D. Group A states the number and type of components. Group B contains all body data. Group C contains all wing data. Group D contains concentrated point mass data. Group B and C has structural and non-structural distributed panel/rod mass data (see Appendix A).

ADAM's output, tape 21, is a complete NASTRAN model. The NASTRAN model is designed for Normal Modes analysis. A plot file is automatically generated so that the first ten eigenvectors or modeshapes can be plotted. A summary table of the input with user warning messages and a card count are on tape 6.

II INPUT PARAMETERS FORMAT

	STEP	PARAMETERS	FORMAT
<u>GROUP A</u>	1	ERROR	11F6.2
	2	NBODY, NWING, NMASS	4(I2,4X)
<u>GROUP B</u>	3	TITLE	8A10
	4	XO,YO, ZO	11F6.2
	5	NANGLE, NFRAME	4(I2,4X)
	6	XFRAME, CAMBER	11F6.2
	7	(ANGLE(I), I=1, NANGLE)	11F6.2
	8	(RADOUT(I), I=1, NANGLE)	11F6.2
	9	(RADIN(I), I=1, NANGLE)	11F6.2

IF STEPS 6 THRU 9 ARE REPEATED NFRAME TIMES (DEFINED ON STEP 5), THEN GO TO STEP 10, OTHERWISE GO TO STEP 6 B.

	STEP	PARAMETERS	FORMAT
	10	IDOF, IKIPAN, IKIPFR, NCG	4(I2, 4X)
	11	PGAUGE, PE, PNU, PMASS	F6.2,E6.1,F6.2,E6.1
	12	RGAUGE, RE, RNU, RMASS, (RTYPE(I), I=1, NANGLE)	F6.2,E6.1,F6.2,E6.1,11A1
	13	SGAUGE, SE, SNU, SMASS, (STYPE(I), I=1, NFRAME)	F6.2,E6.1,F6.2,E6.1,11A1
	14	CGAUGE, CE, CNU, CMASS, XNSM	F6.2,E6.1,F6.2,2E6.1

IF STEPS 3 THRU 14 ARE REPEATED NBODY TIMES (DEFINED ON GROUP A STEP 2), THEN GO TO GROUP C, OTHERWISE GO TO 3 B.

GROUP C	3	TITLE	8A10
	4	XO, YO, ZO, CRO, SO, ALO, ATO, ANGO, WNGDIH	11F6.2
	5	NRB, NSP	4(I2,4X)
	6	(ANRB, I=1, NRB)	11F6.2
	7	(RN(I), I=1, NRB)	11F6.2
	8	(SP(I), I=1, NSP)	11F6.2
	9	NSYM, ZTYPE	4(I2,4X)
	10	(Z1(I,1), I=1, NSP)	11F6.2
	11	(Z1(I,NRB), I=1,NSP)	11F6.2

IF NSYM=-1 (DEFINED ON STEP 9), THEN GO TO STEP 14, OTHERWISE GO TO STEP 12 B.

	12	(Z2(I,1) I=1, NSP)	11F6.2
	13	(Z2(I,NRB), I=1,NSP)	11F6.2
	14	IDOF, IKIPRB, IKIPSP, ISKIN, IRBROT	5(I2,4X)
	15	PGAUGE, PE, PNU, PMASS	F6.2,E6.1,F6.2,E6.1
	16	RGAUGE, RE, RNU, RMASS, (RTYPE(I), I=1, NRB)	F6.2,E6.1,F6.2,F6.1,11A1
	17	SGAUGE, SE, SNU, SMASS, (STYPE(I), I=1, NSP)	F6.2,E6.1,F6.2,E6.1,11A1
	18	CGAUGE, CE, CNU, CMASS, XNSM, DGAUGE, EGAUGE	F6.2,E6.1,F6.2,2E6.1,2F6.2

IF CGAUGE < 0 (DEFINED ON STEP 18), THEN GO TO STEP 19, OTHERWISE GO TO NEXT NOTE.

	19	NELT, TTH, BTH	2I,4X,2F6.2
	20	(TTHICK(I), I=1, NELT)	11F6.2
	21	(BTHICK(I), I=1, NELT)	11F6.2

22	(TTHETA(I), I=1, NELT)	11F6.2
23	(BTHETA(I), I=1, NELT)	11F6.2
24	EX, EY, XYNU, YXNU, G33	2E6.2,2F6.2,E6.2

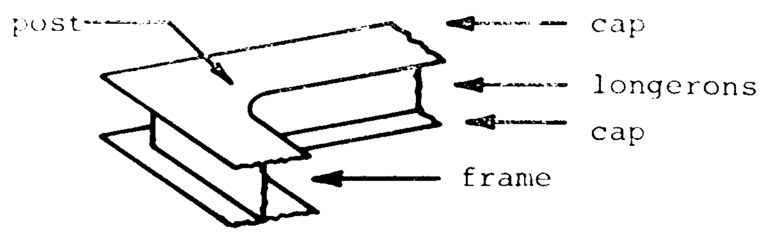
IF STEPS 3 THRU 24 ARE REPEATED NWING TIMES (DEFINED ON GROUP A STEP 2), THEN GO TO GROUP D, OTHERWISE GO TO STEP 3 C.

<u>GROUP D</u> 3	TITLE	8A10
4	XA, YA, ZA, XYZM, AI11, AI21, AI22, AI31, AI32, AI33	11E6.2

IF STEP 4 IS REPEATED NMASS TIMES (DEFINED ON GROUP A STEP 2), THEN STOP, OTHERWISE GO TO STEP 4 D.

III DEFINITIONS OF INPUT PARAMETERS

	STEP	PARAMETER	DEFINITIONS IN ORDER OF USE
GROUP A	1	ERROR	COMBINES GRID POINTS WHICH ARE $\pm$ ERROR DISTANCE APART. WARNING, IF ERROR IS TO LARGE UNDESIRED COMBINATION WILL RESULT. TAPE 6 SUMMARY TABLE DENOTES ERROR IS TOO LARGE WHEN "ELEMENT DEGENERATES INTO A TRIANGLE" IS PRINTED.
	2	NBODY	TOTAL NUMBER OF BODY SECTIONS MODELED.
		NWING	TOTAL NUMBER OF WING SECTIONS MODELED.
		NMASS	TOTAL NUMBER OF MASS POINTS MODELED.
GROUP B	3	TITLE	USER COMMENT CARD FOR EACH BODY.
	4	XO	X-COORDINATE TO POSITION FRAMES.
		YO	Y-COORDINATE TO POSITION FRAMES.
		ZO	Z-COORDINATE TO POSITION FRAMES.
	5	NANGLE	NUMBER OF ANGLES PER FRAME (≤ 22).
		NFRAME	NUMBER OF FRAMES (≤ 22).
	6	XFRAME	X LOCATION OF FRAME RELATIVE TO XO.
		CAMBER	Z LOCATION OF CENTER RELATIVE TO ZO.
	7	ANGLE(I)	ANGLE (IN DEGREES) WHEN LONGERONS ARE DEFINED (POSITIVE Z AXIS IS 0 DEGREES).



Isometric View of Section AA-BB

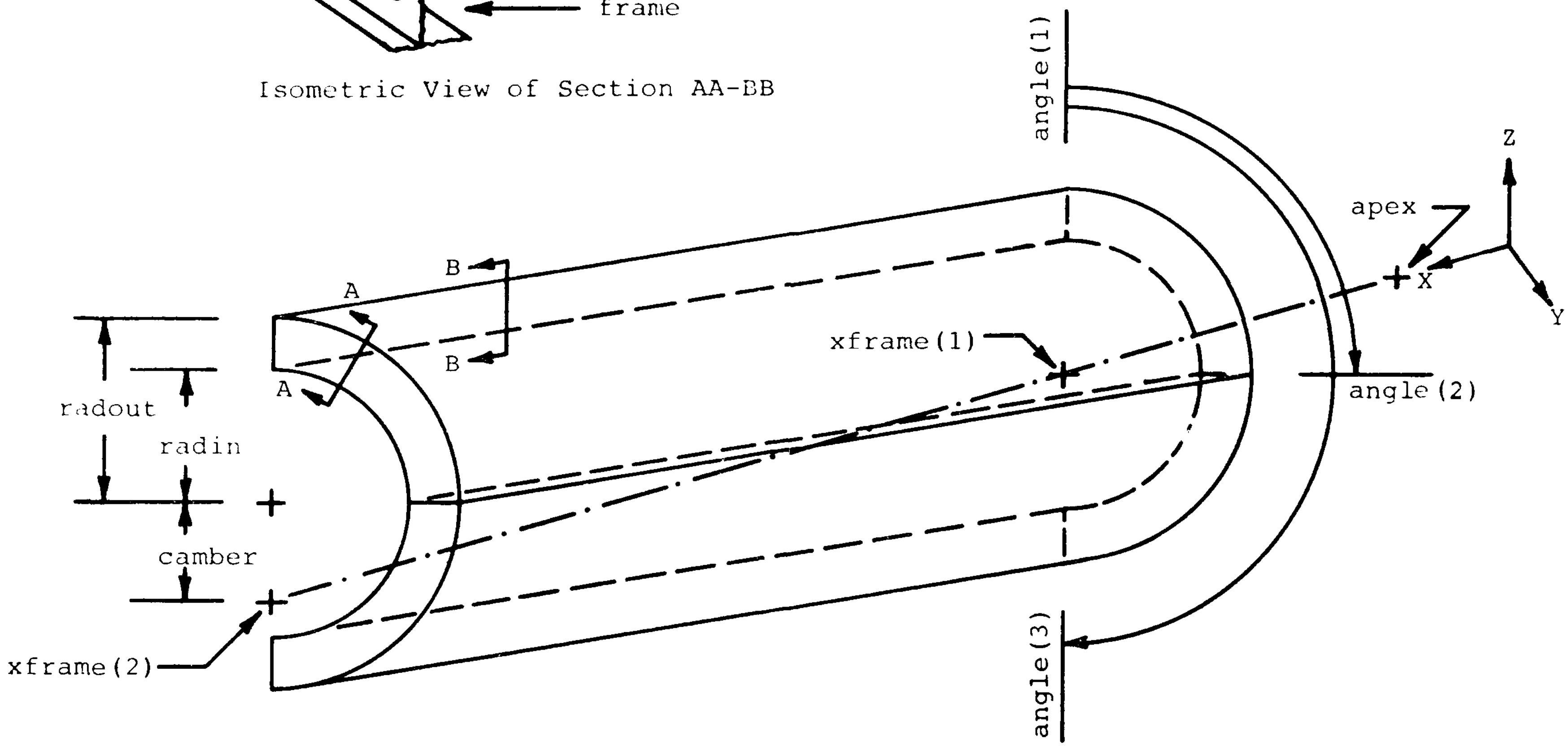


FIGURE 1   BODY GEOMETR   DEF] .TIONS

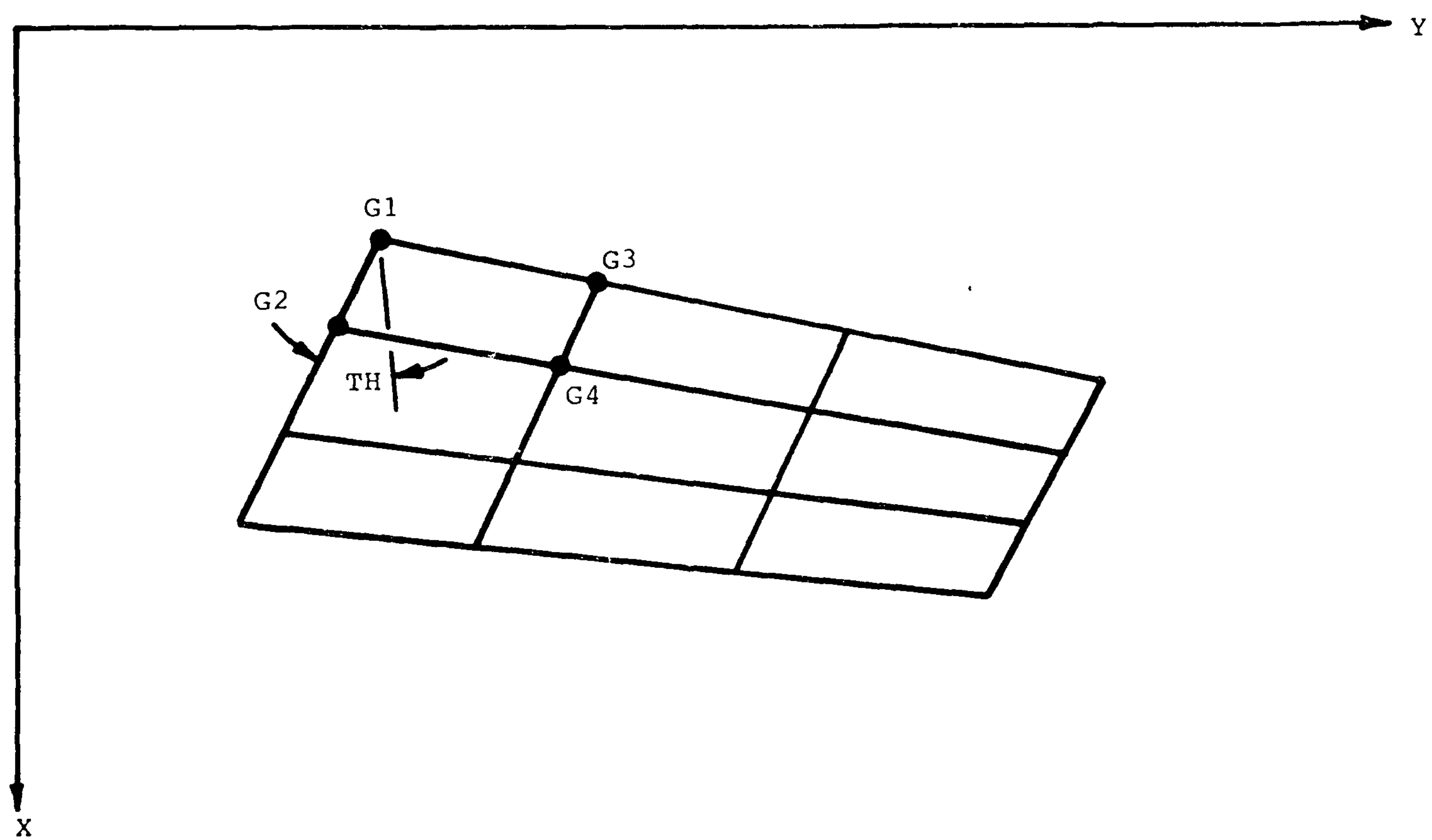
8	RADOUT(I)	OUTER RADIUS OF FRAME.
9	RADIN(I)	INNER RADIUS OF FRAME.

IF STEPS 6 THRU 9 ARE REPEATED NFRAME TIMES (DEFINED ON STEP 5), THEN GO TO STEP 10, OTHERWISE GO TO STEP 6 B.

10	IDOF	DEGREES OF FREEDOM REQUIRED FOR ASET1 CARDS WHICH USES GUYAN REDUCTION. X=1, Y=2, Z=3 GUYAN REDUCTION NOT USED FOR RIGID BODIES. IF IDOF=7, THEN GENERATE SPC1 CARDS FOR A FIXED BODY. IF IDOF=8, THEN GENERATE ASET1 AND SPC1 CARDS FOR A CENTERLINE BODY, WITH SYMMETRIC BOUNDARY CONDITIONS. IF IDOF=9, THEN GENERATE ASET1 AND SPC1 CARDS FOR A CENTERLINE BODY, WITH ANTI-SYMMETRIC BOUNDARY CONDITIONS.
	IKIPAN	THE NUMBER OF LONGERONS SKIPPED. SKIPPED LONGERONS DO NOT HAVE AN ACTIVE DEGREE OF FREEDOM, SEE APPENDIX C.
	IKIPFR	THE NUMBER OF FRAMES SKIPPED. SKIPPED FRAMES DO NOT HAVE AN ACTIVE DEGREE OF FREEDOM, SEE APPENDIX C.
	NCG	FRAME NUMBER TO BE FIXED. CENTER OF GRAVITY IS AT THIS POINT.
11	PGAUGE	CROSS - SECTIONAL AREA OF EACH POST, FRAME AND LONGERONS CAPS (USE .1 INCH FOR TYPICAL AIRCRAFTS).

AI21	MOMENT OF INERTIA	(I21) DEFAULT IS 0.0 .
AI22	MOMENT OF INERTIA	(I22) DEFAULT IS 0.0 .
AI31	MOMENT OF INERTIA	(I31) DEFAULT IS 0.0 .
AI32	MOMENT OF INERTIA	(I32) DEFAULT IS 0.0 .
AI33	MOMENT OF INERTIA	(I33) DEFAULT IS 0.0 .

IF STEP 4 IS REPEATED NMASS TIMES (DEFINED ON GROUP A STEP 2), THEN STOP, OTHERWISE GO TO STEP 4 D.



Top view of wing planform. The stacking order and offset from the neutral axis is not used for in-plane analysis. The fiber orientation angle for each layer is used and is described from the reference angle TH.

FIGURE 5 COMPOSITE FIBER ORIENTATION

21	BTHICK(1)	THICKNESS (IN) OF EACH LAYER FOR BOTTOM SKIN.
22	TTHETA(1)	FIBER ORIENTATION ANGLE (IN DEGREES) OF EACH LAYER FOR TOP SKIN.
23	BTHETA (I)	FIBER ORIENTATION ANGLE (IN DEGREES) OF EACH LAYER FOR BOTTOM SKIN.
24	EX	ELASTIC MODULUS IN THE DIRECTION OF THE X MATERIAL AXIS.
	EY	ELASTIC MODULUS IN THE DIRECTION OF THE Y MATERIAL AXIS.
	XYNU	POISSON'S RATIO FOR TRANSVERSE STRAIN IN THE Y-DIRECTION WHEN STRESS IS APPLIED IN THE X-DIRECTION.
	YXNU	POISSON'S RATIO FOR TRANSVERSE STRAIN IN THE X-DIRECTION WHEN STRESS IS APPLIED IN THE Y-DIRECTION. NOTE: (EX/XYNU = EY/YXNU)
	G33	SHEAR MODULUS.

IF STEPS 3 THRU 24 ARE REPEATED NWING TIMES (DEFINED GROUP A ON STEP 2), THEN GO TO GROUP D, OTHERWISE GO

<u>GROUP D</u> 3	TITLE	USER COMMENT CARD, FOR ALL MASSES.
4	XA	ACTUAL X LOCATION OF MASS.
	YA	ACTUAL Y LOCATION OF MASS.
	ZA	ACTUAL Z LOCATION OF MASS.
	XYZM	MASS (LBS-SEC ^{2}/IN).
	AI11	MOMENT OF INERTIA (I11) DEFAULT IS 0.0 .

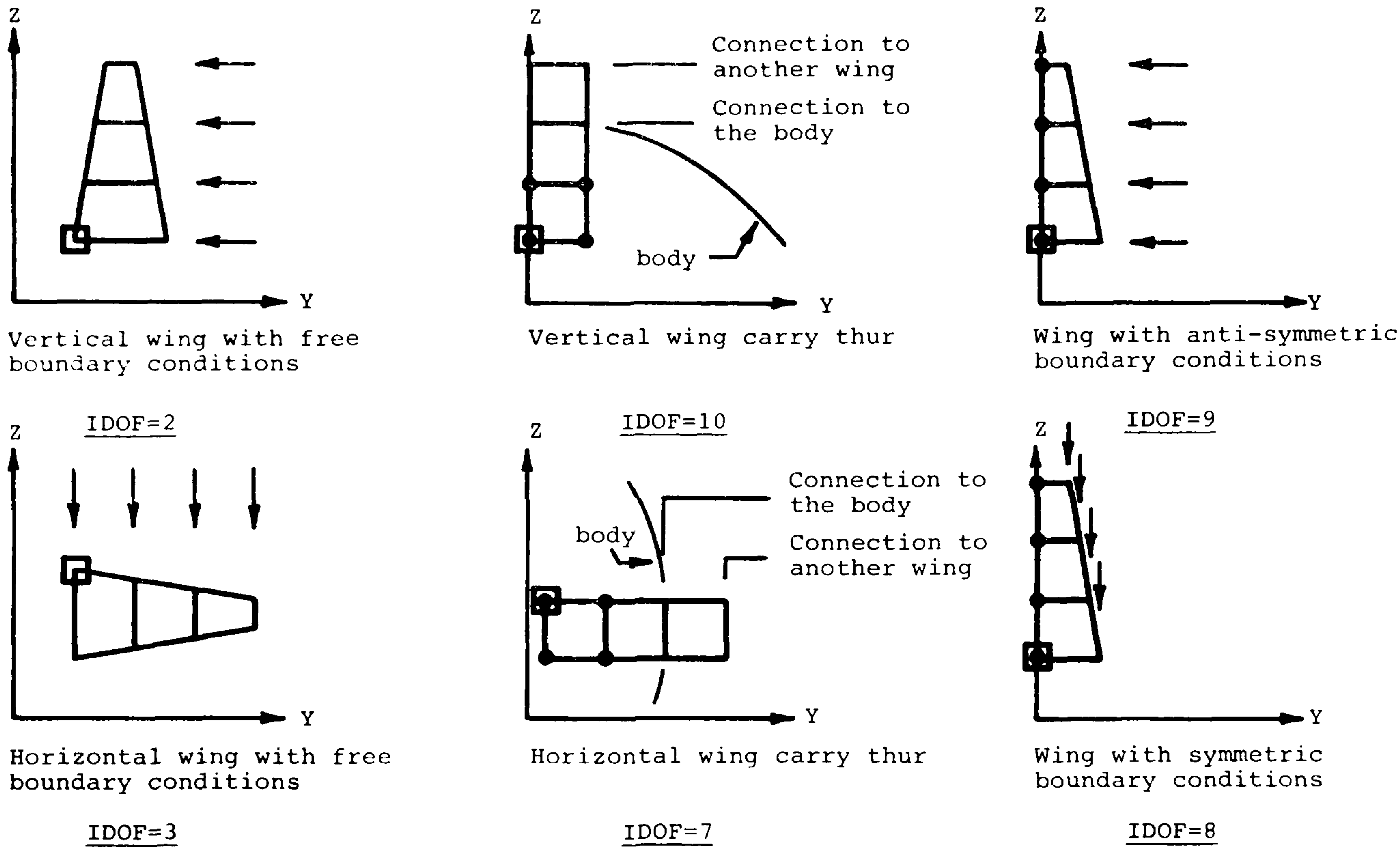
		IF STYPE (I) = 0, THEN NO ELEMENT IS GENERATED FOR THIS SPAR LOCATION.
		IF STYPE (I) = 0, THEN A ELEMENT IS GENERATED FOR THIS SPAR LOCATION.
18	CGUAGE	THICKNESS OF TOP INBOARD SKIN (USE CGUAGE <0. FOR COMPOSITE SKINS), SEE APPENDIX B.
	CE	MODULUS OF ELASTICITY (USE 10.3E6 FOR TYPICAL AIRCRAFT MATERIALS) (USE 0. FOR COMPOSITE SKINS).
	CNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIAL) (USE 0. FOR COMPOSITE SKINS).
	CMASS	MASS (USE 2.5E-4 LBS-SEC^2/IN^4 FOR TYPICAL AIRCRAFT MATERIAL).
	XNMS	NON STRUCTURAL MASS DENSITY (LBS-SEC ^{2}/IN^4), SEE APPENDIX A.
	DGUAGE	THICKNESS OF TOP OUTBOARD SKIN, SEE APPENDIX B.
	EGUAGE	THICKNESS OF BOTTOM INBOARD SKIN, SEE APPENDIX B.

IF C GUAGE < 0, (DEFINED ON STEP 18), THEN GO TO STEP 19, OTHERWISE GO TO NEXT NOTE.

19	NELT	NUMBER OF ELEMENTS IN LAY UP ($\leq$ 11)
	TTH	REFERENCE ANGLE (IN DEGREES) FOR TOP SKIN FROM POSITIVE X AXIS.
	BTH	REFERENCE ANGLE (IN DEGREES) FOR BOTTOM SKIN FROM POSITIVE X AXIS.
20	TTHICK(1)	THICKNESS (IN) OF EACH LAYER FOR TOP SKIN.

16	RGUAGE	THICKNESS OF EACH RIB.
	RE	MODULUS OF ELASTICITY (UAW 1 .3E6 FOR TYPICAL AIRCRAFT MATERIALS).
	RNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIALS)
	RMASS	MASS DENSITY (USE 2.5E-4 $1BS\text{-}SEC^2/IN^4$ FOR TYPICAL AIRCRAFT MATERIALS).
	RTYPE(1)	SKIP SHEAR PANEL FOR THE ith RIB; NUMBERING STARTS WITH TIP RIB. IF RTYPE (I) = 0, THEN NO ELEMENT IS GENERATED FOR THIS RIB LOCATION. IF RTYPE (I) = 1, THEN AN ELEMENT IS GENERATED FOR THIS RIB LOCATION.
17	SGUAGE	THICKNESS OF EACH SPAR.
	SE	MODULUS OF ELASTICITY (USE 10.3 E6 FOR TYPICAL AIRCRAFT MATERIALS).
	SNU	POISSON'S RATIO (USE .033 FOR TYPICAL AIRCRAFT MATERIALS).
	SMASS	MASS DENSITY (USE $2.5E\text{-}41BS\text{-}SEC^2/IN^4$ FOR TYPICAL AIRCRAFT MATERIALS).
	STYPE	SKIP SHEAR PANEL FOR THE ith SPAR; NUMBERING STARTS WITH THE TRAILING EDGE SPAR.

	IKIPRB	THE NUMBER OF RIBS SKIPPED. SKIPPED RIBS DO NOT HAVE AN ACTIVE DEGREE OF FREEDOM, SEE APPENDIX C.
	IKIPSP	THE NUMBER OF SPARS SKIPPED. SKIPPED SPARS DO NOT HAVE AN ACTIVE DEGREE OF FREEDOM, SEE APPENDIX C.
	ISKIN	NUMBER OF SKIN SURFACES TO INCLUDE IN THE ACTIVE DEGREE OF FREEDOM. IF ISKIN =2, THEN THE UPPER AND LOWER SKINS ARE INCLUDED. IF ISKIN =1, THEN THE UPPER SKIN ONLY IS INCLUDED.
	IRBROT	RIB ROTATION INDICTOR. IF IRBOT = 1, THEN THE FIRST RIB WILL NOT ROTATE. IF IRBOT = 0, THEN ALL RIBS ARE ROTATED.
15	PGAUGE	CROSS - SECTIONAL AREA OF EACH POST, SPAR AND RIB CAPS. (USE .1 INCH FOR TYPICAL AIRCRAFT).
	PE	MOUDULUS OF ELASTICITY (USE 10.3E6 FOR TYPICAL
	PNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIALS
	PMASS	MASS DENSITY (USE 2.5E-4 LBS-SEC^2 /IN^4 FOR TYPICAL AIRCRAFT MATERIALS).



Cross section view looking from leading to trailing edge of wing section. The arrows, ↓, denote the direction of the active degree of freedom. The squares, □ , denote the apex. The dots, ●, denote the point is fixed. If IDOF is equal to 8, 9 or 10, the apex must be on the centerline.

FIGURE 4 WING BOUNDARY CONDITIONS

Z DIRECTION, AND IDOF =2 FOR VERTICAL TAILS BENDING IN THE Y DIRECTION).

X=1, Y=2, Z=3,

GUYAN REDUCTION NOT USED FOR WING BOX CARRY THRU.

IF IDOF=7, THEN GENERATE SPC1 CARDS FOR A WING BOX CARRY THRU WHICH IS CONNECTED TO A CENTERLINE BODY AND CONNECTED TO A WING. LAST TWO RIBS ARE FREE, ALL OTHERS ARE FIXED. THE (NRB-1)TH RIB IS CONNECTED TO THE CENTERLINE BODY AND THE (NRB)TH RIB IS CONNECTED TO A WING.

WHEN IDOF=8, 9, OR 10, THEN WNGDIH=+90 DEGREES. THE TOP SURFACE IS ROTATED TO THE CENTERLINE. ALL TOP SURFACE Z1(I,1) VALUES SHOULD EQUAL 0.0.

IF IDOF=8, THEN GENERATE SPC1 AND ASET1 CARDS FOR A CENTERLINE WING, WITH SYMMETRIC BOUNDARY CONDITIONS.

IF IDOF=9, THEN GENERATE SPC1 AND ASET1 CARDS FOR A CENTERLINE WING, WITH ANTI-SYMMETRIC BOUNDARY CONDITIONS.

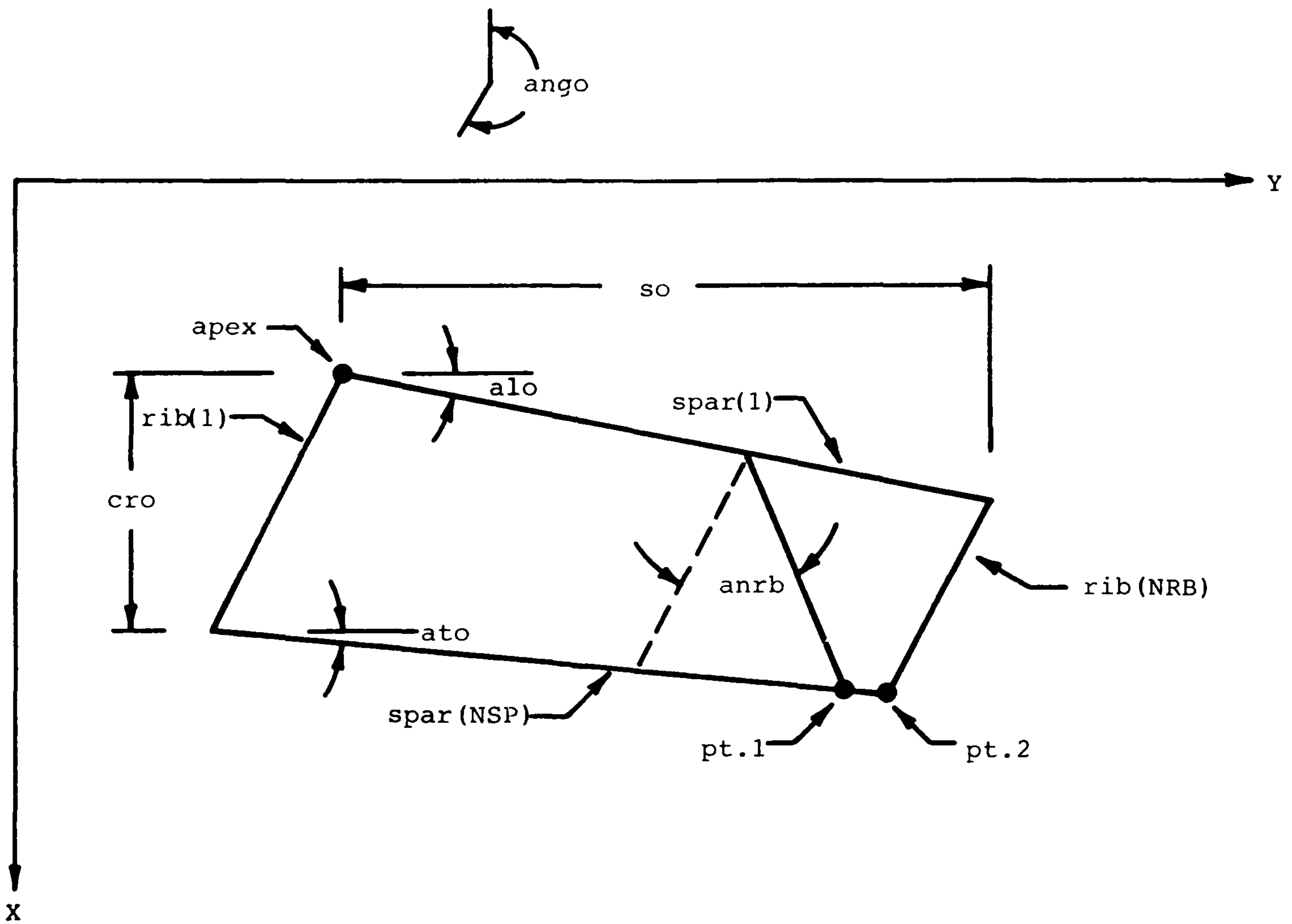
IF IDOF=10, THEN GENERATE SPC1 CARDS FOR A CENTERLINE WING BOX CARRY THRU WHICH IS CONNECTED TO A CENTERLINE BODY AND CONNECTED TO A CENTERLINE WING. LAST TWO RIBS ARE FREE, ALL OTHERS ARE FIXED. THE (NRB-1)TH RIB IS CONNECTED TO THE CENTERLINE BODY AND THE (RNB)TH RIB IS CONNECTED TO A CENTERLINE WING.

		FRACTION OF THE CHORD, REFERENCED FROM THE LEADING EDGE).
9	NSYM	OPTION TO HAVE A SYMMETRICAL STRUCTURAL BOX: IF XSYM = -1, THEN ZTOP = -ZBOTTOM. IF ZSYM = 0, THEN ZBOTTOM DESCRIBED BY STEPS 10 AND 11.
	ZTYPE	OPTION TO SUPPLY AN ACTUAL/SCALED Z-COORDINATES: IF ZTYPE = 1, THEN USE ACTUAL Z-COORDINATES. IF ZTYPE = 0, THEN NONDIMENSIONAL Z-COORDINATES ARE GIVEN AND INTERNALLY ARE MULTIPLIED BY THE CHORD.
10	Z1(I, 1)	ARRAY OF Z-COORDINATES FOR THE TOP SURFACE FOR THE FIRST RIB IN THE STRUCTURAL BOX (AIRFOIL SHAPE).
11	Z1(I, NRB)	ARRAY OF Z-COORDINATES FOR THE TOP SURFACE FOR THE LAST RIB IN THE STRUCTURAL BOX (AIRFOIL SHAPE).

IF NSYM = -1 (DEFINED ON STEP 9), THEN GO TO STEP 14, OTHERWISE GO TO STEP 12 C.

12	Z2(I,1)	ARRAY OF Z-COORDINATES FOR THE BOTTOM SURFACE FOR THE FIRST RIB IN THE STRUCTURAL BOX.
13	Z2(I, NRB)	ARRAY OF Z-COORDINATES FOR THE BOTTOM SURFACE FOR THE LAST RIB IN THE STRUCTURAL BOX.
14	IDOF	DEGREES OF FREEDOM REQUIRED FOR ASET1 CARDS WHICH USES GUYAN REDUCTION. (USE IDOF=3 FOR WINGS BENDING IN THE

	CRO	ROOT CHORD OF THE WING.
	SO	SEMI-SPAN OF THE WING.
	ALO	LEADING EDGE SWEEP ANGLE (IN DEGREES).
	ATO	TRAILING EDGE SWEEP ANGLE (IN DEGREES).
	ANGO	ANGLE (IN DEGREES) WHICH RIBS MAKE WITH THE X-AXIS. (ANGO = 0.0 IF THE RIBS ARE PARALLEL TO THE X-AXIS AND A POSITIVE NUMBER, OTHERWISE.)
	WNGDIH	WING DIHEDRAL ANGLE (IN DEGREES) ROTATED ABOUT APEX. IF WING DIHERAL IS NEGATIVE THE APEX MUST BE ON THE BOTTOM SURFACE. IF WING DIHERAL IS POSITIVE THE APEX MUST BE ON THE TOP SURFACE. IF WNGDIH EQUALS +90 DEGREES THE WING IS A VERTICAL WING.
5	NRB	TOTAL NUMBER OF RIBS IN THE STRUCTURAL BOX ($\leq$22).
	NSP	TOTAL NUMBER OF SPARS IN THE STRUCTURAL BOX ($\leq$22). (USE ODD NUMBERS FOR NRB AND NSP TO HAVE ACTIVE DEGREES OF FREEDOM ON WING BOX EDGES).
6	ANRB(I)	ARRAY WHICH SPECIFIES THE RIB ANGLE (IN DEGREES), REFERENCED FROM FIRST SPAR AT RIB(I)). RIB(I) IS ROTATED ANGO DEGREES FROM THE X-AXIS AND MODIFIED BY ANRB(I).
7	RN(I)	ARRAY WHICH SPECIFIES THE LOCATIONS OF THE RIBS (AS FRACTIONS OF THE SPAN, REFERENCED FROM THE ROOT CHORD).
8	SP(I)	ARRAY WHICH SPECIFIES THE LOCATIONS OF THE SPAR (AS DECIMAL



Top view of wing planform. If pt.1 is rotated such that pt.1 equals pt.2, the quadrilaterals degenerate into triangles.

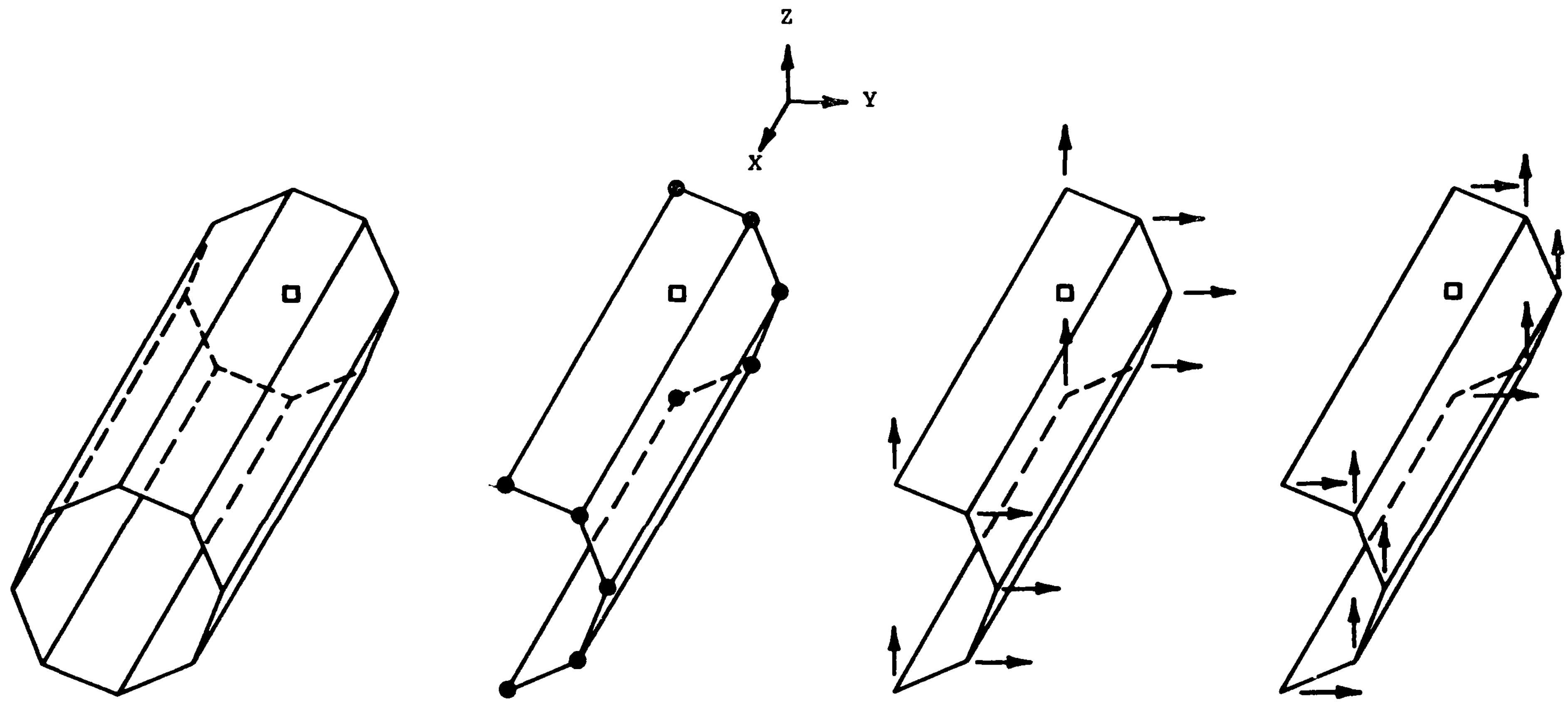
FIGURE 3 WING GEOMETRIC DEFINITIONS

			MATERIALS).
		STYPE	SKIP SHEAR PANEL FOR THE ith FRAME; NUMBERING STARTS WITH THE TRAILING EDGE FRAME. IF STYPE (I) = 0, THEN NO ELEMENT IS GENERATED FOR THIS FRAME LOCATION. IF STYPE (I) = 1, THEN AN ELEMENT IS GENERATED FOR THIS FRAME LOCATION.
	14	CGAUGE	THICKNESS OF SKIN.
		CE	MODULUS OF ELASTICITY (USE 10.3E6 FOR TYPICAL AIRCRAFT MATERIALS).
		CNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIAL).
		CMASS	MASS DENSITY (USE 2.5E-4 LBS-SEC^2/IN^4 FOR TYPICAL AIRCRAFT MATERIAL).
		XNSM	NON STRUCTURAL MASS DENSITY (LBS-SEC ^{2}/IN^4), SEE APPENDIX A

IF STEPS 3 THRU 14 ARE REPEATED NBODY TIMES (DEFINED ON GROUP A, STEP 2), THEN GO TO GROUP C, OTHERWISE GO TO STEP 3 B.

GROUP C	3	TITLE	USER COMMENT CARD, FOR EACH WING.
	4	XO	X-COORDINATE OF THE APEX POINT OF THE WING (OR TAIL).
		YO	Y-COORDINATE OF THE APEX POINT OF THE WING (OR TAIL).
		ZO	Z-COORDINATE OF THE APEX POINT OF THE WING (OR TAIL).

	PE	MOUDULUS OF ELASTICITY (USE 10.3E6 FOR TYPICAL AIRCRAFT MATERIALS).
	PNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIALS).
	PMASS	MASS DENSITY (USE 2.5E-4 LBS-SEC^2/IN^4 FOR TYPICAL AIRCRAFT MATERIALS).
12	RGAUGE	THICKNESS OF EACH STRINGER.
	RE	MODULUS OF ELASTICITY (USE 1 .3E6 FOR TYPICAL AIRCRAFT MATERIALS).
	RNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIALS).
	RMASS	MASS (USE 2.5E-4 LBS-SEC^2/IN FOR TYPICAL AIRCRAFT MATERIALS).
	RTYPE(I)	SKIP SHEAR PANEL FOR THE ith RIB; NUMBERING STARTS WITH FIRST LONGERONS. IF RTYPE(I) = 0, THEN NO ELEMENT IS GENERATED FOR THIS LONGERONS LOCATION. IF RTYPE (I) = 1, THEN A ELEMENT IS GENERATED FOR THIS LONGERONS LOCATION.
13	SGAUGE	THICKNESS OF EACH FRAME.
	SE	MODULUS OF ELASTICITY (USE 10.3 E6 FOR TYPICAL AIRCRAFT MATERIALS).
	SNU	POISSON'S RATIO (USE 0.33 FOR TYPICAL AIRCRAFT MATERIALS)
	SMASS	MASS DENSITY (USE 2.5E-4 LBS-SEC^2/IN^4 FOR TYPICAL AIRCRAFT



User defined active degree of freedom:

1 for X direction
2 for Y direction
3 for Z direction

IDOF = 1, 2, 3

All points are fixed

IDOF = 7

The centerline is fixed in the X and Y direction. Centerline has active degree of freedom in Z direction. All other points have an active degree of freedom in the Y direction.

IDOF = 8

The centerline is fixed in the X and Z direction. Centerline has active degree of freedom in Y direction. All other points have an active degree of freedom in the Z direction.

IDOF = 9

The arrows, ↓, denote the direction of the active degree of freedom. The squares, □, denote APEX. The dots, ●, denote the point is fixed.

FIGURE 2 BODY BOUNDARY CONDITIONS

APPENDIX A

Non Structural Mass Density, XNSM is used in Group B and C. This parameter is designed to distribute non structural mass based upon the volume of wings or body.

The input to ADAM is:

$$\frac{\text{density}}{\text{gravity}} = \frac{\text{lbs/in}^3}{\text{in/sec}^2} = \frac{.1}{386}$$

ADAM calculates the thickness for wings:

Upper Skin Z1

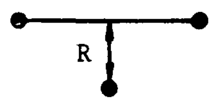
Lower Skin Z2

Average Thickness = (Z1 - Z2)/2

ADAM calculates the thickness for bodies:

Skin

Center



Average Thickness = R/2

The input to NASTRAN for homogenous skins is:

(XNSM) * (Thickness) = ($\text{lbs} - \text{sec}^2/\text{in}^3$)

The input to NASTRAN for composite skins is:

(XNSM) * (Thickness/Nelt) = ($\text{lbs} - \text{sec}^2/\text{in}^3$) where Nelt equals the number of stacked elements.

NASTRAN internally distributes the mass to grid points:

($\text{lbs} - \text{sec}^2/\text{in}^3$) * ($\text{in}^2$) = ($\text{lbs} - \text{sec}^2/\text{in}$)

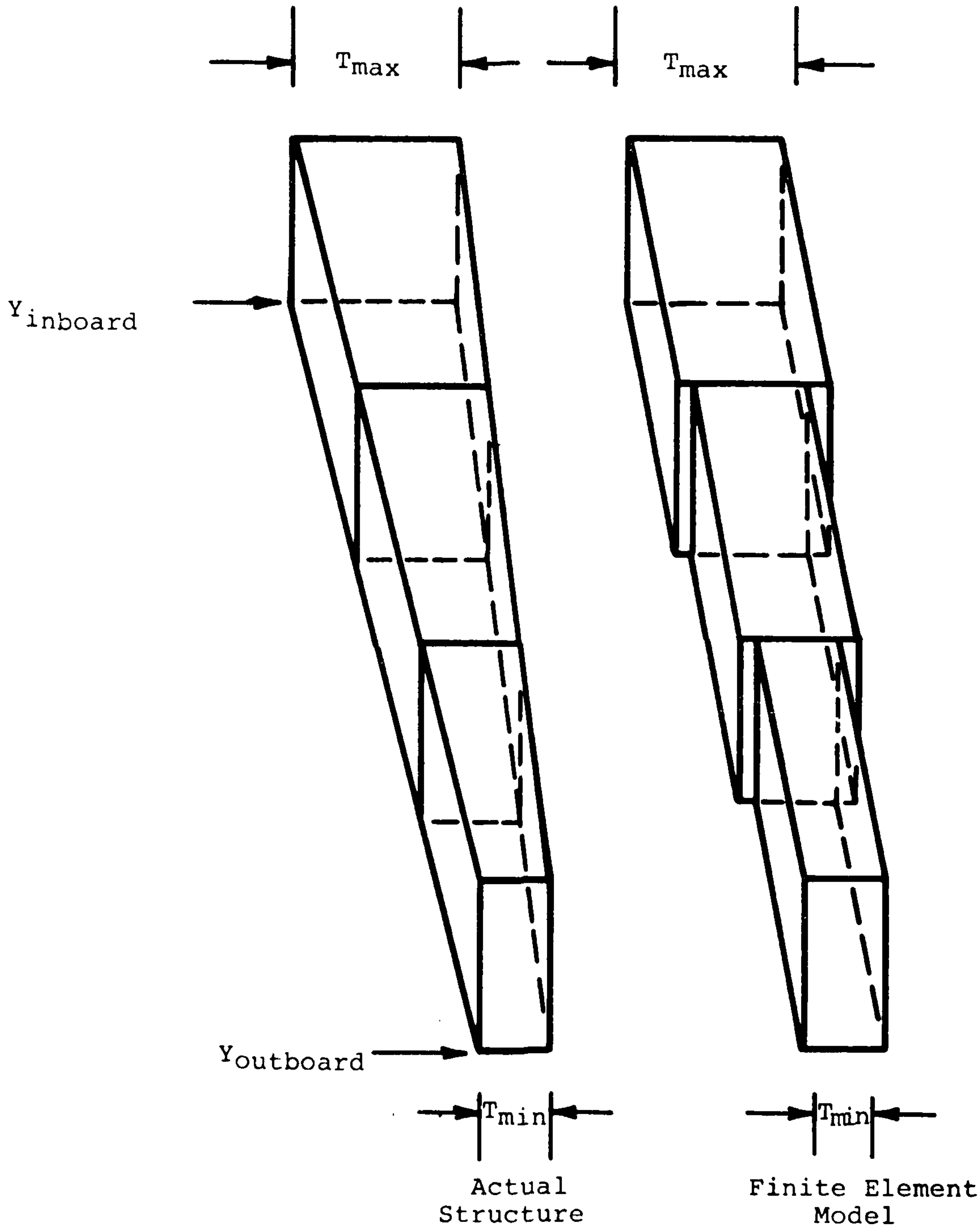


FIGURE 6 SKIN TAPERING

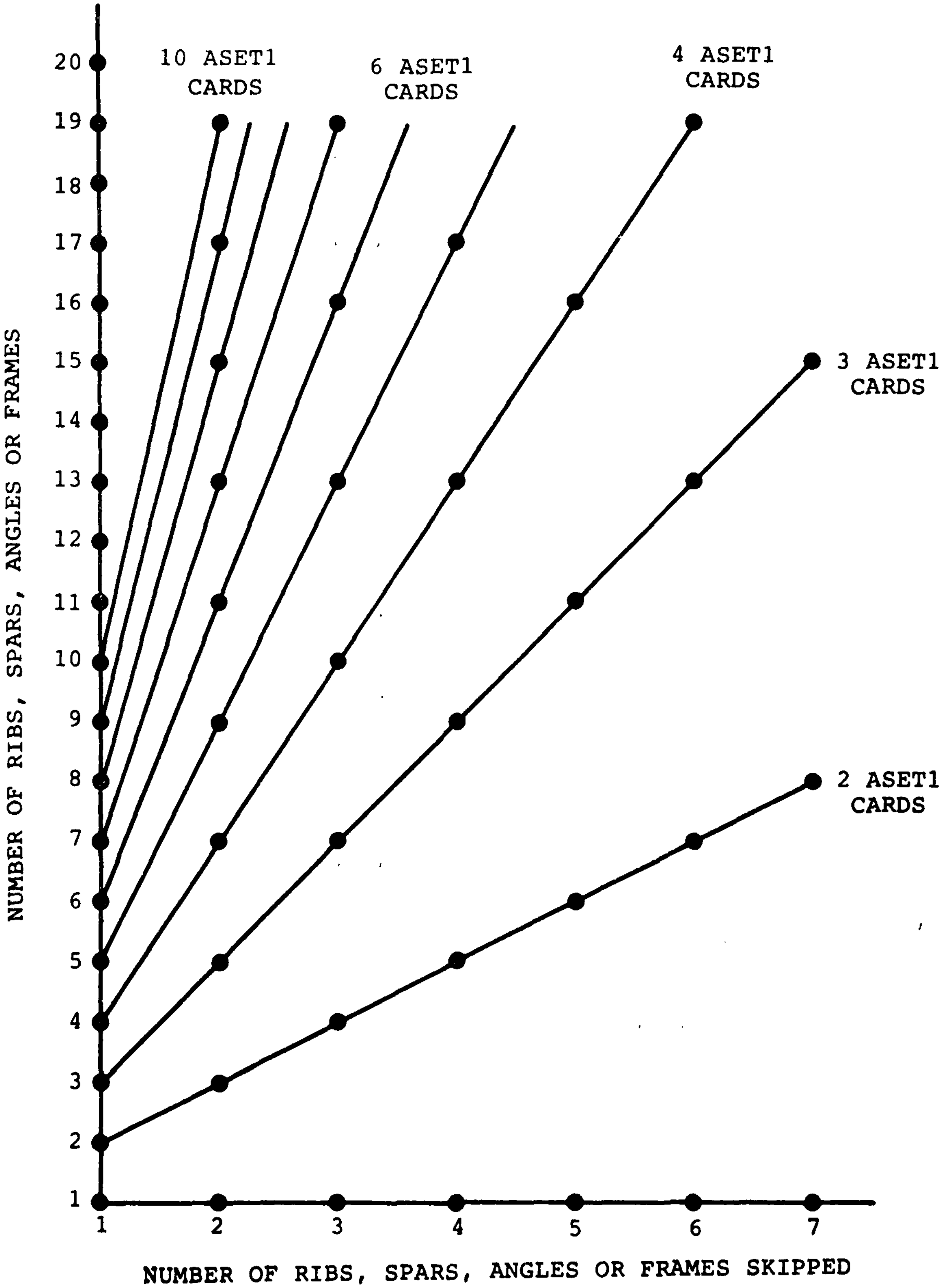


FIGURE 7 MODE SHAPE CHART

```
MAIN SUBROUTINE

C    GENERATE CARD:
       GRDSET          456
C    READ GROUP A INPUT
C    BODY CALLS
       CALL MODEB
       CALL ELEMB
C    WING CALLS
       CALL NODEW
       CALL ELEMW
C    COMBINE FILES CALL
       CALL CLEAN
```

```
NODEB SUBROUTINE

C    READ GROUP B INPUT
C    GENERATE CARDS:
     GRID GID XYZ
     ASET1 IDOF GID
     SPC1 SET IDOF GID
```

```
ELEMB SUBROUTINE

C    READ GROUP B INPUT
C    GENERATE CARDS:
     CROD EID PID G1 G2
     CSHEAR EID PID G1 G2 G3 G4
     CQDMEM2 EID PID G1 Gs G3 G4
     PROD PID MID T
     PSHEAR PID MID T
     PQDMEM2 PID MID T
     MAT1 MID E NU MASS
```

```
NODEW SUBROUTINE

C    READ GROUP C INPUT
C    GENERATE CARDS:
     GRID GID XYZ
     ASET1 IDOF GID
     SPC1 SET IDOF GID
```

```
ELEMW SUBROUTINE

C    READ GROUP C INPUT
C    GENERATE CARDS:
     CROD E1D P1D GI G2
     CSHEAR EID PID G1 G2 G3 G4
     CQDMEM2 EID PID G1 G2 G3 G4
     PROD PID MID T
     PSHEAR PID ID T
     PQDMEM2 PID MID T
     MAT1 MID E NU MASS
```

```
CLEAN SUBROUTINE

C    DELETES DUPLICATE GRID POINTS
C    WRITES ALL DATA ON TAPE 21
C    MASS CALLS
       CALL MASS
```

```
MASS SUBROUTINE

C    READ GROUP D INPUT
C    GENERATE CARD:
     CONM2 ID OX OY OZ MASS
     I11 I21 I22 I31 I32 I33
C    COMPARES MASS LOCATION WITH
     GRID POINT LOCATION AND CALCULATES
     MINIMUM OFF SET DISTANCE
```

FIGURE 8 FLOW DIAGRAM

APPENDIX E

Execution of ADAM on CDC at WPFB:

/ Attach, BADAM/UN=E780403

/ Get, Data=Your File

/ BADAM

The NASTRAN data is on Tape 21.

The input summary table is on Tape 6.

Execution of EZPL on CDC at WPFB:

/ Attach, EZPL=EZPLTEK/UN=D740292

/ Rewind, Tape21

/ Copy, Tape21, Tape5

/ Rewind, Tape5

/ EZPL

END

FILMED

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